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Extracorporeal Hand-Sewn vs. Intracorporeal Mechanic Anastomosis During Laparoscopic Right Colectomy

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ABSTRACT

Background and Objectives: To compare the outcomes of extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) versus intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) during laparoscopic right hemicolectomy for adenocarcinoma.

Methods: This is a retrospective propensity score-matched analysis of prospectively collected data. Fifty-four patients who underwent surgery with EHSIA (intervention group) were paired with 54 patients who underwent surgery with IMSIA (control group) based on patients' demographics and type of surgery (standard right hemicolectomy or extended right hemicolectomy).

Results: Fifty-four patients were included for each group. Statistically significant differences between groups were not observed in patients' demographics and type of surgery. Conversion occurred in three patients of the intervention group due to intra-abdominal adhesions for previous surgery (5.6%) ($p = 0.079$). Median operative time was statistically significant shorter in the control group in comparison to the intervention group (85 and 117.5 minutes, respectively, $p \leq 0.0001$). In both groups one anastomotic leakage was observed (1.9%) (Clavien-Dindo grade III-a). In the control group one patient (1.9%) underwent reintervention for acute postoperative anemia (Clavien-Dindo grade III-b). Median number of harvested lymph-nodes was 17 and 12 ($p \leq 0.0001$), in the intervention and the control group, respectively. Median hospital stay was statistically significant lower in the control group in comparison to the intervention group (5 and 6.5 days, respectively, $p \leq 0.013$).

Conclusion: IMSIA showed lower operative time and hospital stay in comparison to EHSIA. Further randomized studies are required to draw definitive conclusions about the best anastomotic technique during laparoscopic right hemicolectomy.

Key Words: Anastomotic bleeding, Anastomotic leakage, Extracorporeal anastomosis (ECA), Intracorporeal anastomosis (ICA), Laparoscopic right hemicolectomy.

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INTRODUCTION

Laparoscopic right hemicolectomy for adenocarcinoma is a feasible and safe procedure, both in terms of surgical and oncological results.[1] It is well recognized in the literature that minimally invasive right hemicolectomy has several advantages in comparison to open surgery, such as reduced blood loss, less postoperative pain, quicker return to normal bowel function, reduced immunosuppression, and shorter postoperative hospital stay.[2]

In the last decade, the research about minimally invasive surgery (MIS) for right hemicolectomy continued with the aim to improve the already encouraging results.[1–4] For this purpose, robotic surgery, Enhanced Recovery After Surgery (ERAS) protocol, and single port hemicolectomy have been proposed.[1–4] A great effort has been also dedicated about the investigation regarding the intracorporeal

(ICA) versus extracorporeal anastomosis (ECA) during minimally invasive right hemicolectomy.[1] As reported in the literature, the most employed surgical technique for the anastomosis creation, both in case of ICA and ECA, is the mechanical one with the hand-sewn closure of the enterotomy.[1]

The aim of the present propensity score-matched (PSM) analysis is to compare the surgical outcomes in patients who underwent laparoscopic right hemicolectomy with extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) and intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) for adenocarcinoma.

MATERIALS AND METHODS

This is a retrospective PSM analysis of prospectively collected data. Institutional review board approval and informed consent from all participants were obtained.

From October 1, 2018 to November 30, 2021, 66 patients underwent right hemicolectomy in Hospital San Paolo in Civitavecchia, Rome, Italy. Of these, 57 patients underwent elective laparoscopic right hemicolectomy with EHSIA for adenocarcinoma. Three patients were excluded from this study due to associated cholecystectomy was performed during right hemicolectomy. Finally, 54 patients were included in this analysis, forming the intervention group.

From October 1, 2014 to July 31, 2021, 93 patients underwent elective laparoscopic right hemicolectomy with IMSIA for adenocarcinoma without associated procedures in University Hospital Virgen del Rocio in Sevilla, Spain, forming the control group (**Figure 1**).

Pre-operative mechanical bowel preparation was administered to both groups of patients and ERAS protocol was not used in any case.

Surgical Technique

All surgical procedures were performed by laparoscopy under general anesthesia. The procedures were performed by the Chief Surgeons of both Units (P.L. and S.M.C.).

Laparoscopic Right Hemicolectomy with EHSIA

Patient is in supine position and with adducted legs. The surgeon stands at the patient's left side. Four trocars are used. Surgery is performed by bipolar diathermy (LigaSure™ tissue fusion, Covidien, Mansfield, Massachusetts, USA). The first step of the procedure is the identification and division between Hem-o-lok (Weck® Hem-o-lok®, Teleflex, North Carolina, USA) of the ileocolic vessels at their origin. Right colon with hepatic flexure is then mobilized using the medial to lateral approach and the parietocolic groove is opened.

A median supraumbilical abdominal wall incision of about 5–10 cm is performed and protected by a wound protector (Alexis, Applied Medical, Rancho Santa Margarita, California, USA) for the right colon and ileum extraction. Both ileum and colon are divided with 75 mm linear stapler (Linear Stapler, Ethicon™, Cincinnati, Ohio, USA). In the last 10 patients of this experience, the supposed section lines are marked by the surgeon using the electric scalpel, and after that indocyanine green (ICG) is administered to perform the fluorescence angiography to decide the exact section level based on the fluorescence imaging. In all cases, before the anastomosis, colonic and ileal stumps were reinforced by a hemostatic hand-sewn continuous suture in prolene 5.0.

Ileum and colon are approached side-to-side, isoperistaltic, by a row of single stitches in vicryl 2.0 (step 1). Then, the colon and ileal walls at the antimesenteric sides of the terminal ileum and the transverse colon (tenia) are opened by a cold blade scalpel, above the row of single stitches (step 2). Two stitches in vicryl 2.0 are placed in the middle of the posterior wall of the anastomosis and their tails are tied together (step 3). Both stitches serve as semicontinuous suture, starting from the middle of the posterior wall of the anastomosis up to the anterior wall of the anastomosis (step 4). The two sutures are tied together in the center of the anterior wall of the anastomosis (step 5). After that, just above the anastomosis, another row of single stitches in vicryl 2.0 is performed (step 6). If necessary, single stitches of reinforcement are placed at the corners of the anastomosis (**Figure 2**). The mesenteric defect is always closed. Specimen is removed using the median incision.

Laparoscopic Right Hemicolectomy with IMSIA

Patient is placed in supine position with open legs. The surgeon stands at the patient's left side. Four trocars are used. Surgery is performed by bipolar diathermy (LigaSure™ tissue fusion, Covidien, Mansfield, Massachusetts, USA). The first step of the procedure is the retroperitoneal dissection and duodenum identification. The hepatic flexure is mobilized using the medial to lateral approach. The ileocolic and right colic artery and vein are identified and divided by bipolar diathermy, and the right parietocolic groove is opened. Before dividing the terminal ileum and the transverse colon, the supposed section lines are marked by the surgeon using the electric scalpel, and after that ICG is administered in order to perform the fluorescence angiography to decide the exact section level. Based on the fluorescence imaging, terminal ileum is divided using a linear stapler (Endo GIA^{TM} Ultra Universal Stapler, Covidien, Minneapolis, Minnesota, USA) with a 60 mm white cartridge and the transverse colon with a 60 mm purple cartridge.

Ileum and colon are approached side-to-side, isoperistaltic, and an enterotomy is performed on each side by a monopolar diathermy (step 1). The intracorporeal mechanic anastomosis is performed with a linear stapler (60 mm purple cartridge) (step 2). In order to reduce the anastomotic tension, a stitch in vicryl 2.0 is placed between the ileum and colon behind the anastomosis (step 3). The enterotomy is closed using two continuous sutures with absorbable 2.0 barbed suture (V-loc^{TM}, Medtronic, Minneapolis, Minnesota, USA). The first continuous suture is placed in the upper part of the enterotomy and served as traction for the anastomosis anchoring it to the peritoneum of the abdominal wall (step 4). The second continuous suture is placed in the lower part of the enterotomy to finish its closure (step 5). After that, the two continuous sutures are tied between them (step 6) (**Figure 3**).

Specimen is removed using a Pfannesteil incision protected by a wound protector (Alexis, Applied Medical, Rancho Santa Margarita, California, USA).

In both cases, after the anastomosis creation, hemostasis is performed if necessary, and drainage is placed in the site of the trocar in right iliac fossa according to surgeon's preference.

Study Data and Analysis

Gender, age, body mass index (BMI), comorbidities (including hypertension, ischemic heart disease, type 2 diabetes mellitus, and smoking habit) American Society

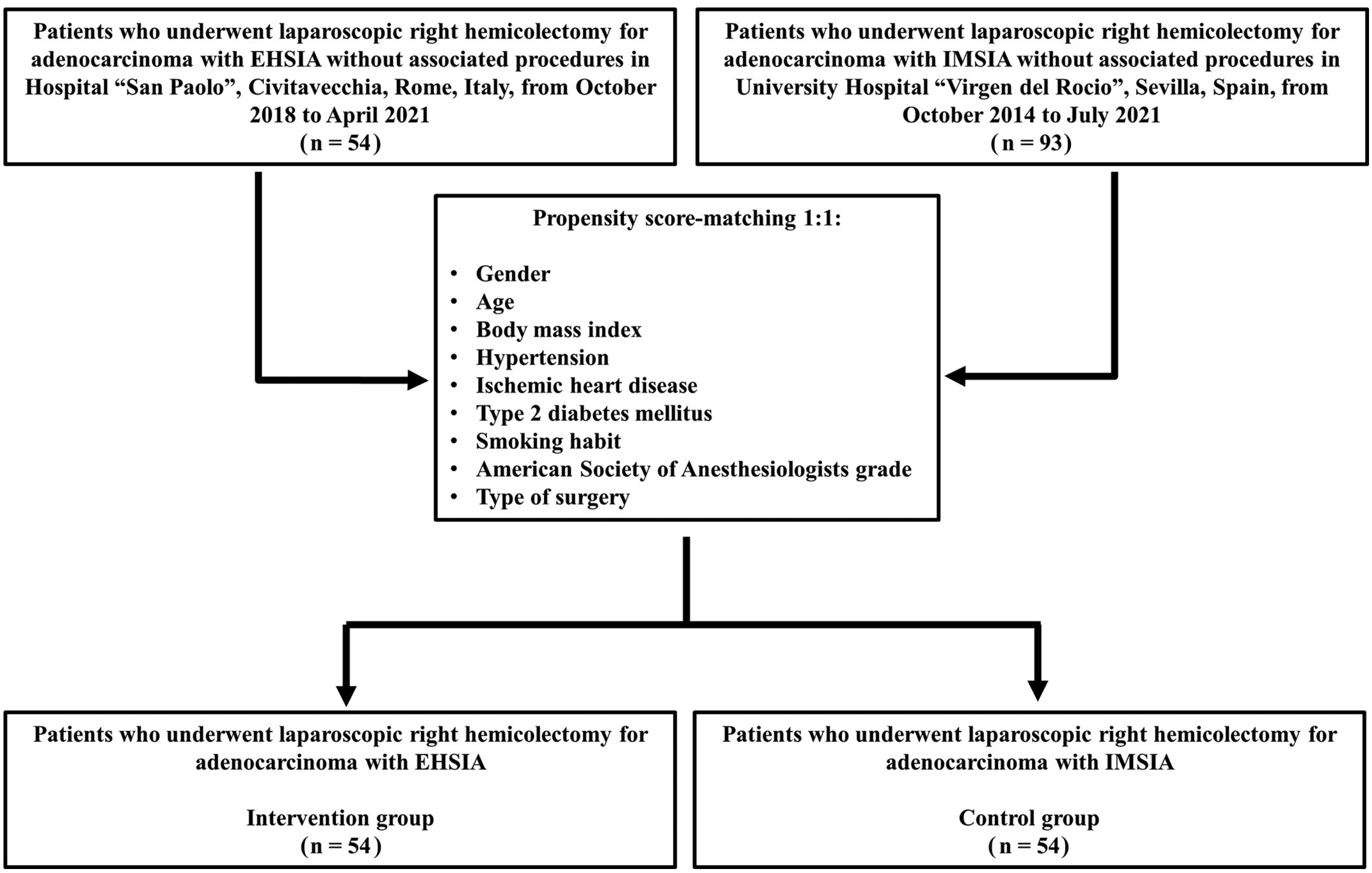

Figure 1. Patient selection. Abbreviations: EHSIA, Extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis; IMSIA, Intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis.

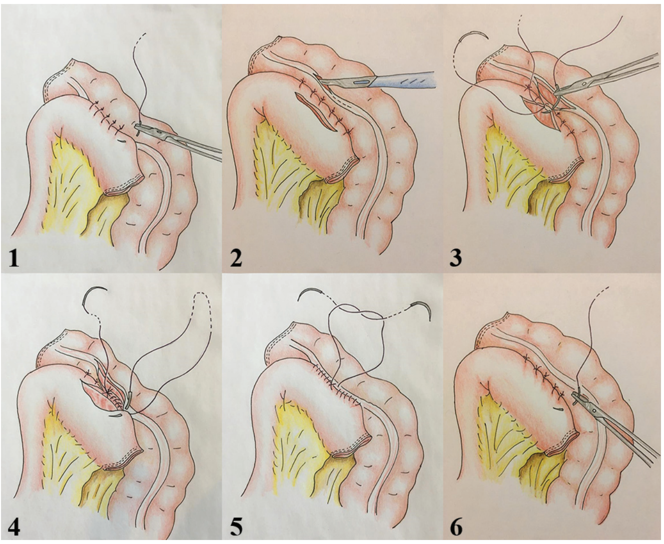

Figure 2. Extracorporeal hand-sewn side-to-side isoperistaltic ileocolic anastomosis (EHSIA) technique. 1) Ileum and colon are approached side-to-side, isoperistaltic, by a row of single stitches in vicryl 2.0. 2) Above the row of single stitches, colon and ileum are opened by a cold blade scalpel. 3) Two stitches in vicryl 2.0 are placed in the middle of the posterior wall of the anastomosis and their tails are tied together. 4) Both stitches serve as semi-continuous suture, starting from the middle of the posterior wall of the anastomosis up to the anterior wall of the anastomosis. 5) The two sutures are tied together in the center of the anterior wall of the anastomosis. 6) Above the anastomosis created another row of single stitches in vicryl 2.0 is performed.

of Anesthesiologists (ASA) grade, type of surgery (standard right hemicolectomy or extended right hemicolectomy), intraoperative complications, conversion to open surgery, operative time, postoperative complications (graded according to the Clavien-Dindo classification[5]), number of harvested lymph-nodes, radicality of resection, reintervention, postoperative hospital stay, 30-day mortality, readmission, and incisional hernia occurrence were recorded in a Microsoft Excel program (Microsoft Corporation, Redmond, Washington, USA).

Statistical Analysis

Continuous variables are expressed as median and 95% confidence intervals (CI) and categorical variables such as frequencies and percentages. The nonparametric Mann Whitney *U* test and χ^2 test were used for the comparison between groups of continuous and categorical variables, respectively.

In order to minimize the risk of bias and potential confounding factors, and improve the validity of the statistical comparison, the PSM analysis was performed to match 1:1 patients of the intervention and the control groups, using the following covariates which might affect the peri and postoperative outcomes: gender, age, BMI, hypertension, ischemic heart disease, diabetes, smoking habit, ASA grade, and type of surgery.

A p value lower than 0.05 was considered statistically significant. Statistical analyses were carried out with IBM SPSS software 22.0 (SPSS Inc., Chicago, Illinois, USA).

RESULTS

After the PSM analysis 54 patients were included for each group (**Figure 1**). Results are reported in **Table 1**. After pairing, statistically significant differences between intervention and control group were not observed in patients' demographics and type of surgery.

Conversion to open surgery occurred in three patients of the intervention group due to intra-abdominal visceral adhesions for previous surgery (5.6%), while conversion did not occur in the control group. After pairing a statistically significant difference was not observed (P = .079). Median operative time was statistically significant shorter

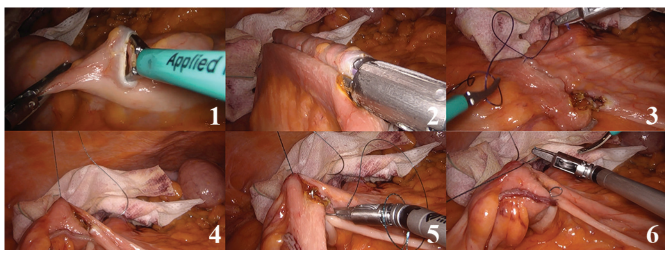

Figure 3. Intracorporeal mechanic side-to-side isoperistaltic ileocolic anastomosis (IMSIA) technique. Ileum and colon are approached side-to-side, isoperistaltic, and an enterotomy is performed on each side by a monopolar diathermy (Step 1). The intracorporeal mechanic anastomosis is performed with a linear stapler (60 mm purple cartridge) (Step 2). In order to reduce the anastomotic tension, a stitch in vicryl 2.0 is placed between the ileum and colon behind the anastomosis (Step 3). The enterotomy is closed using two continuous suture with absorbable 2.0 barbed suture (V-locTM, Medtronic, Minneapolis, Minnesota, USA). The first continuous suture is placed in the upper part of the enterotomy and served as traction for the anastomosis anchoring it to the peritoneum of the abdominal wall (Step 4). The second continuous suture is placed in the lower part of the enterotomy to finish its closure (Step 5). After that, the two continuous sutures are tied between them (Step 6).

Table 1.
Results

	Before Propensity Score Matching			After Propensity Score Matching		
	Intervention group (n = 54)	Control group (n = 93)	p value	Intervention group (n = 54)	Control group (n = 54)	p value
Sex ratio (Men : Women)	32 (59.3) : 22 (40.7)	50 (53.8) : 43 (46.2)	0.518	32 (59.3) : 22 (40.7)	27 (50) : 27 (50)	0.334
Median age, years (CI 95%)	74 (68.9–74.6)	70 (67.2–71.5)	0.142	74 (68.9–74.6)	71.5 (69.4–74.5)	0.856
Median body mass index, kg/m^2 (CI 95%)	25.5 (24.9–27.1)	26.7 (26.4–28)	0.053	25.5 (24.9–27.1)	25.8 (25.2–27.2)	0.652
Comorbidities, n (%)						
Hypertension	30 (55.6)	40 (43)	0.142	30 (55.6)	26 (48.1)	0.441
Ischemic heart disease	4 (7.4)	12 (12.9)	0.302	4 (7.4)	7 (13)	0.340
Type 2 diabetes mellitus	9 (16.7)	18 (19.4)	0.685	9 (16.7)	12 (22.2)	0.466
Smoking habit	14 (25.9)	23 (24.7)	0.872	14 (25.9)	14 (25.9)	0.909
ASA grade, n (%)						
I	1 (1.9)	6 (6.5)	0.432	1 (1.9)	1 (1.9)	1.000
II	21 (30.9)	47 (50.5)	0.229	21 (30.9)	23 (42.6)	0.844
III	29 (53.7)	40 (43)	0.233	29 (53.7)	30 (55.6)	1.000
IV	3 (5.6)	–	**0.022***	3 (5.6)	–	0.079
Type of surgery, n (%)						
Right hemicolectomy	46 (85.2)	86 (92.5)		46 (85.2)	49 (90.7)	0.375
Extended right hemicolectomy	8 (14.8)	7 (7.5)	0.159	8 (14.8)	5 (9.3)	
Intraoperative complications, n (%)	–	–	1.000	–	–	1.000
Conversions to open surgery, n (%) Adhesions	3 (5.6)	–	**0.022***	3 (5.6)	–	0.079
Median operative time, minutes (CI 95%)	117.5 (113.1–127.1)	85 (80.6–90.6)	**<0.0001***	117.5 (113.1–127.1)	85 (80–94.3)	**<0.0001***
Complications, n (%), Clavien-Dindo classification, grade)						
Ileum	7 (13, I)	8 (8.6, I)	0.400	7 (13, I)	4 (7.4, I)	0.340
Anemia required transfusion	3 (5.6, II)	1 (1.1, II)	0.107	3 (5.6, II)	1 (1.9, II)	0.308
Acute cholecystitis	1 (1.9, II)	–	0.188	1 (1.9, II)	–	0.315
Rectorrhagia	–	1 (1.1, II)	0.445	–	1 (1.9, II)	0.315
Pneumonia	1 (1.9, II)	–	0.188	1 (1.9, II)	–	0.315
Wound infection	5 (9.3, II)	3 (3.2, II)	0.120	5 (9.3, II)	2 (3.7, II)	0.241
Anemia required surgery	–	1 (1.1, III-b)	0.445	–	1 (1.9, III-b)	0.315

Table 1. Continued

	Before Propensity Score Matching			After Propensity Score Matching		
	Intervention group (n = 54)	Control group (n = 93)	p value	Intervention group (n = 54)	Control group (n = 54)	p value
Anastomotic leakage	1 (1.9, III-a)	2 (2.2, IIIa, III-b)	0.902	1 (1.9, III-a)	1 (1.9, IIIa)	1.000
Pulmonary embolism	–	1 (1.1, IV)	0.445	–	1 (1.9, IV)	0.315
Cardiovascular complications	–	1 (1.1, IV)	0.278	–	–	1.000
Median number of harvested lymph-nodes (CI 95%)	17 (16.6–20)	12 (12–13.1)	**<0.0001***	17 (16.6–20)	12 (11.7–13.4)	**<0.0001***
R0 resection, n (%)	54 (100)	93 (100)	1.000	54 (100)	54 (100)	1.000
Reintervention, n (%)	–	2 (2.2)	0.278	–	1 (1.9)	0.315
Median hospital stay, days (CI 95%)	6.5 (5.9–7)	5 (4.9–7.8)	**<0.0001***	6.5 (5.9–7)	5 (4.8–9.8)	**0.013***
30-day mortality, n (%)	–	–	1.000	–	–	1.000
Re-admission, n (%)	–	1 (1.1)	0.445	–	–	1.000
Incisional hernia occurrence, n (%)	1 (1.9)	1 (1.1)	0.695	1 (1.9)	–	0.315

*Statistically significant differences in bold.
Abbreviation: CI, confidence interval.

in the control group in comparison to the intervention group before (80 and 117.5 minutes, respectively, p ≤ 0.0001) and after pairing (85 and 117.5 minutes, respectively, p ≤ 0.0001) (**Table 1**).

After PSM analysis, in both groups one anastomotic leakage was observed (1.9%), both treated by computed tomography scan guided radiological drainage (Clavien-Dindo grade III-a). In the control group one patient (1.9%) underwent reintervention for acute postoperative anemia, however no signs of intra-abdominal bleeding were observed (Clavien-Dindo grade III-b) (**Table 1**).

Median number of harvested lymph-nodes was statistically significant higher in the intervention group in comparison to the control group before and after PSM analysis (17 and 12 lymph-nodes, respectively, p ≤ 0.0001) (**Table 1**).

Median postoperative hospital stay was significantly lower in the control group in comparison to the intervention group before (5 and 6.5 days, respectively, p ≤ 0.0001) and after the PSM analysis (5 and 6.5 days, respectively, p ≤ 0.013). Mortality was nil in both group (**Table 1**).

At median follow up of 23 (CI 95% 17.7 – 23.4) and 45 months (CI 95% 33.2 – 45.5) for the intervention and the control group, respectively, one incisional hernia was observed in the intervention group after PSM analysis (1.9%) (P = .315) (**Table 1**).

DISCUSSION

The present study was conducted with the aim to compare the surgical outcomes obtained with laparoscopic right hemicolectomy with EHSIA versus IMSIA, in patients with adenocarcinoma. Overall, the only statistically significant differences observed between the two groups were the operative time and hospital stay in favor of IMSIA and the number of harvested lymph-nodes in favor of EHSIA, while statistically significant differences were not observed about other analyzed variables.

Several studies, in which ECA versus ICA are compared, have been recently published (**Table 2**).[6–22] ICA required longer operative time, although the overall complication rate, including the anastomotic leakage rate, is similar between ECA and ICA (**Table 2**).[6–22] In the present series, this data was not confirmed as shorter operative times were observed with ICA.

As expected, and as in the present study, ICA is always performed in the same manner, using a laparoscopic linear stapler closing the enterotomy by a hand-sewn

Table 2.
Articles About the Comparison Between Extra and Intracorporeal Anastomosis During Laparoscopic Right Hemicolectomy

	Number of patients		Median Operative Time, minutes (range)		Anastomotic Leakage Rate, n (%)		Anastomotic Bleeding Rate, n (%)		Median Hospital Stay, days (range)	
Authors	ECA	ICA	ECA	ICA	ECA	ICA	ECA	ICA	ECA	ICA
Bollo *et al.*[6]†	70	69	123 (60–240)	149 (95–215)	5 (7)	34	10 (14)	2 (3)	6.6 (2–23)	5.7 (2–19)
Ishizaki *et al.*[7]†	50	51	198 (78–402)	211 (176–343)	0	0	0	0	11 (7–23)	10 (7–16)
Vignali *et al.*[8]†	30	30	Mean 135 ± 27	Mean 158.5 ± 30.8	2 (6.6)	0	0	0	n.r.	n.r.
Trépanier *et al.*[9]†	155	71	Mean 144.4 ± 48.1	Mean 164.6 ± 40	8 (5.2)	2 (2.8)	0	0	3^{3-5}	3 (2–4)
Hanna *et al.*[10]†	109	86	184.5 (IQR 138–232.5)	183 (IQR 140–217)	5 (4.6)	1 (1.2)	0	0	5 (IQR 4–7)	5 (IQR 3–7)
Magistro *et al.*[11]†	40	40	Mean 203 ± 48	Mean 230 ± 45	0	0	3 (7.5)	2 (5)	Mean 6 ± 1.8	Mean 6.3 ± 3.1
Scatizzi *et al.*[12]†	40	40	150 (105–245)	150 (115–180)	0	0	0	0	5 (3–15)	5 (3–10)
Anania *et al.*[13]†	69	80	190 (IQR 170–220)	162.5 (IQR 135–197.5)	n.r.	n.r.	n.r.	n.r.	8 (IQR 7–11)	7 (IQR 6–9)
Cleary *et al.*[14]†	124	156	Mean 175.5 ± 56	Mean 208.5 ± 55.9	0	1 (0.6)	2 (1.6)	3 (1.9)	Mean 4.4 ± 1.5	Mean 4.2 ± 3.1
Ferrer-Márquez *et al.*[15]†	78	82	Mean 97.35 ± 28.05	Mean 100.18 ± 37.43	6 (7.7)	4 (4.9)	0	0	Mean 8.58 ± 5.75	Mean 11.5 ± 20.73
Zhang *et al.*[16]†	180	120	Mean 163.2 ± 38.5	Mean 163.7 ± 41.9	2 (1.1)	1 (0.8)	1 (0.5)	1 (0.8)	Mean 7.8 ± 2.2	Mean 6.1 ± 2.4
Allaix *et al.*[17]*	70	70	130 (110–180)	130 (105–195)	2 (2.9)	7 (10)	1 (1.4)	1 (1.4)	6 (5–7)	6 (5–8)
Biondi *et al.*[18]*	54	54	Mean 188.77 ± 59.15	Mean 195.65 ± 51.46	1 (1.9)	0	0	0	Mean 6.81	Mean 4.79
Jarry *et al.*[19]*	79	43	150 (IQR 120–180)	180 (IQR 150–205)	3 (3.8)	2 (4.7)	7 (8.89)	3 (7)	4 (IQR 3–6)	3 (IQR 3–4)
Saleh *et al.*[20]*	447	150	195 (60–695)	150 (90–360)	10 (2)	64	0	0	8 (3–56)	7 (3–28)
Hoyuela *et al.*[21]*	55	53	Mean 146 ± 40.3	Mean 156 ± 36.2	4 (7.3)	0	3 (3.6)	6 (11.3)	Mean 10.8 ± 9.6	Mean 5.2 ± 3.3
Małczak *et al.*[22a]	50	52	190 (150–230)	190 (180–220)	2 (4)	0	2 (4)	0	4^{3-5}	4^{3-6}
Present series	54	54	117.5 (CI 95% 113.1–127.1)	85 (CI 95% 80–94.3)	1 (1.9)	1 (1.9)	0	1 (1.9)	6.5 (CI 95% 5.9–7)	5 (CI 95% 4.8–9.8)

Abbreviations: ECA, extracorporeal anastomosis; ICA, intracorporeal anastomosis; IQR, interquartile range; CI, confidence interval; n.r., not reported.
†extracorporeal mechanic anastomosis; *extracorporeal anastomosis performed by either stapler or hand-sewn suture; [a]extracorporeal hand-sewn anastomosis.

suture or by another stapled line.[6–22] On the other hand, ECA is performed by linear stapler in most cases,[6–16] but some authors performed ECA by either stapler or hand-sewn suture,[17–21] and few by hand-sewn (**Table 2**).[22]

In our series, in patients who underwent surgery with ECA, an ileal and colonic stump staple line reinforcement is performed to control a possible further source of bleeding. The cold blade scalpel is used to allow a better scarring of the anastomosis in comparison to the electric scalpel.

Our results do not differ from those reported in literature, in comparison with ICA and mechanical or manual ECA.[6–22] It is important to consider that in the literature some authors reported shorter hospital stay in comparison to the present series, but in their studies the ERAS protocol is adopted.[6,8,9,22]

In the present series, encouraging results are observed also in terms of harvested lymph-nodes, re-admission, re-operation, and mortality rates in comparison to the literature both in case of ICA and ECA,[6–22] despite the small number of patients. Even if the median number of harvested lymph-nodes between groups is statistically significantly different, in both groups it is sufficient to make a correct tumor staging, and, moreover, the number of analyzed lymph-nodes could depend on the different pathologists from the two included centers.

Although an important difference is not observed comparing the anastomotic leakage rate between ECA and ICA, some authors advocated that leakage after ICA is related to higher clinical impact due to the severity of dehiscence in comparison to ECA.[6–22] This could be related, even if not demonstrated, to the fact that the mechanical anastomosis is performed by a single layer suture in comparison to most of the manual anastomosis performed by a double layer suture,[23,24] as in the present series. Espin et al. reported an analysis of 116 patients who experienced anastomotic leakage after right hemicolectomy.[23] Anastomotic leakages were stratified based on the type of the anastomosis (manual versus mechanical) and grade of leakage based on the Clavien-Dindo classification and on the International Study Group of Rectal Cancer (ISGRC) classification.[5,25] They found that Clavien-Dindo grade III-a leakage is more frequent in patients who underwent hand-sewn anastomosis, and that grade III-b leakage is more frequent in patients who underwent stapled anastomosis.[23] Similarly, ISGRC grade C leakage is more frequent in patients who underwent stapled anastomosis.[23] In our opinion, even if further studies are required to draw definitive conclusions about the severity of postoperative anastomotic leakage based on the type of the anastomosis, the treatment required in case of anastomotic leakage, such as re-operation and re-admission should be considered among the endpoints when ECA and ICA are compared. However, in the present series, anastomotic leakages III-b were not observed with ICA.

The cost to perform a mechanical anastomosis is higher in comparison to a hand-sewn anastomosis and this is related to the cost of the tristaple device in comparison to vicryl suture.[26,27] In case of mechanical anastomosis, despite the major cost of the procedure could be compensated by a shorter hospital stay, another important charge could be represented by the expense necessary to treat more serious leakages, that could require re-admission and re-operation. Further studies are necessary to investigate about the cost management of these patients.

Another aspect to consider, even if is not the object of the present study, is the possibility to perform a hand-sewn anastomosis in specific situations, such as in case of inflammatory bowel disease.[28] In these cases hand-sewn anastomosis may be a valid alternative to mechanical one, allowing to surgeon to shape the anastomosis if necessary.

Finally, the high incidence of wound infection and incisional hernia after midline laparotomy in comparison to Pfannesteil incision is wide reported in literature,[29,30] even if this data is not confirmed in the present study.

Few articles reported data regarding extraction site incisional hernia after minimally invasive right hemicolectomy with ICA or ECA, and it is probably due to the short follow up.[6–22,31] Hanna et al. reported an incisional hernia rate of 2% and 5% in patients in which ICA and ECA were performed, respectively, at median follow up of 10 and seven months after surgery.[10] Allaix et al., six months after surgery, reported an incisional hernia rate of 1.4% and 2.9% with ICA and ECA, respectively.[17] Otherwise from previous authors, Biondi et al. reported an important difference regarding incisional hernia rate between ICA (1.9%) and ECA (21.2%).[18] Even if we have to consider the wide difference of follow-up between the two groups (ICA: median 9.52 months, ECA: median 26.69 months). In our series the incisional hernia rate is 1.9% in the ECA group. Although long-term follow-up is required to draw definitive conclusions, in literature, incisional hernia rate is higher in patients who underwent right hemicolectomy with ECA.[10,17,18] In our opinion, also the necessity of incisional hernia repair should be included in the cost management of these patients.

The main limitations of the present study are its retrospective nature, the small sample size of each group that may have affect the statistical analysis, different pathologies that may have affected the number of analyzed lymph-nodes, different surgeons involved from two centers, and the lack of the analysis of postoperative pain.

CONCLUSION

Based on the present study, laparoscopic right hemicolectomy with EHSIA and IMSIA showed intra and postoperative results similar to those reported in literature, in terms of operative time, anastomotic leakage, bleeding, and length of hospital stay. Further randomized studies are required to draw definitive conclusions regarding outcomes between EHSIA and IMSIA during laparoscopic right hemicolectomy.

References:

1. Selvy M, Mattevi C, Slim K, Pezet D, Pereira B, Le Roy B. Intra-versus extracorporeal anastomosis in laparoscopic right colectomy: a meta-analysis of 3699 patients. *Int J Colorectal Dis*. 2020;35(9):1673–1680.

2. Feroci F, Giani I, Baraghini M, et al. Barbed versus traditional suture for enterotomy closure after laparoscopic right

colectomy with intracorporeal mechanical anastomosis: a case-control study. *Updates Surg.* 2018;70(4):433–439.

3. Migliore M, Giuffrida MC, Marano A, et al. Robotic versus laparoscopic right colectomy within a systematic ERAS protocol: a propensity-weighted analysis. *Updates Surg.* 2021;73(3):1057–1064.

4. Dong B, Luo Z, Lu J, et al. Single-incision laparoscopic versus conventional laparoscopic right colectomy: a systematic review and meta-analysis. *Int J Surg.* 2018;55:31–38.

5. Clavien PA, Barkun J, de Oliveira ML, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg.* 2009;250(2):187–196.

6. Bollo J, Turrado V, Rabal A, et al. Randomized clinical trial of intracorporeal versus extracorporeal anastomosis in laparoscopic right colectomy (IEA trial). *Br J Surg.* 2020;107(4):364–372.

7. Ishizaki T, Katsumata K, Enomoto M, et al. Comparison of intra-abdominal infection risk between intracorporeal and extracorporeal anastomosis in laparoscopic right hemicolectomy for colon cancer: a single-center retrospective study. *Am Surg.* 2021;87(3):341–346.

8. Vignali A, Bissolati M, De Nardi P, Di Palo S, Staudacher C. Extracorporeal vs. intracorporeal ileocolic stapled anastomoses in laparoscopic right colectomy: an interim analysis of a randomized clinical trial. *J Laparoendosc Adv Surg Tech A.* 2016;26(5):343–348.

9. Trépanier M, Valin-Thorburn A, Kouyoumdjian A, et al. Intracorporeal versus extracorporeal anastomosis for right colectomy does not affect gastrointestinal recovery within an enhanced recovery after surgery program. *Surg Endosc.* 2020;34(10):4601–4608.

10. Hanna MH, Hwang GS, Phelan MJ, et al. Laparoscopic right hemicolectomy: short- and long-term outcomes of intracorporeal versus extracorporeal anastomosis. *Surg Endosc.* 2016; 30(9):3933–3942.

11. Magistro C, Lernia SD, Ferrari G, et al. Totally laparoscopic versus laparoscopic-assisted right colectomy for colon cancer: is there any advantage in short-term outcomes? A prospective comparative assessment in our center. *Surg Endosc.* 2013; 27(7):2613–2618.

12. Scatizzi M, Kröning KC, Borrelli A, Andan G, Lenzi E, Feroci F. Extracorporeal versus intracorporeal anastomosis after laparoscopic right colectomy for cancer: a case-control study. *World J Surg.* 2010;34(12):2902–2908.

13. Anania G, Tamburini N, Sanzi M, et al. Extracorporeal versus intracorporeal anastomosis in laparoscopic right hemicolectomy for cancer. *Minim Invasive Ther Allied Technol.* 2022;31:1, 112–118.

14. Cleary RK, Silviera M, Reidy TJ, et al. Intracorporeal and extracorporeal anastomosis for robotic-assisted and laparoscopic right colectomy: short-term outcomes of a multi-center prospective trial. *Surg Endosc.* 2022;36(6):4349–4358.

15. Ferrer-Márquez M, Rubio-Gil F, Torres-Fernández R, et al. Intracorporeal versus extracorporeal anastomosis in patients undergoing laparoscopic right hemicolectomy: a multicenter randomized clinical trial (The IVEA-study). *Surg Laparosc Endosc Percutan Tech.* 2021;31(4):408–413.

16. Zhang M, Lu Z, Zheng Z, Cheng P, Zhou H, Wang X. Comparison of short-term outcomes between totally laparoscopic right colectomy and laparoscopic-assisted right colectomy: a retrospective study in a single institution on 300 consecutive patients. *Surg Endosc.* 2022;36(1):176–184.

17. Allaix ME, Degiuli M, Bonino MA, et al. Intracorporeal or extracorporeal ileocolic anastomosis after laparoscopic right colectomy: a double-blinded randomized controlled trial. *Ann Surg.* 2019;270(5):762–767.

18. Biondi A, Santocchi P, Pennestrì F, Santullo F, D'Ugo D, Persiani R. Totally laparoscopic right colectomy versus laparoscopically assisted right colectomy: a propensity score analysis. *Surg Endosc.* 2017;31(12):5275–5282.

19. Jarry C, Cárcamo L, González JJ, et al. Implementation of intracorporeal anastomosis in laparoscopic right colectomy is safe and associated with a shorter hospital stay. *Updates Surg.* 2021;73(1):93–100.

20. Bou Saleh N, Voron T, De'Angelis N, et al. Intracorporeal versus extracorporeal anastomosis in laparoscopic right hemicolectomy: results from the CLIMHET study group. *Tech Coloproctol.* 2020;24(6):585–592.

21. Hoyuela C, Guillaumes S, Ardid J, et al. The impact of intracorporeal anastomosis in right laparoscopic colectomy in the surgical site infections and the hospital stay: a cohort study. *Updates Surg.* 2021;73(6):2125–2135.

22. Małczak P, Wysocki M, Pisarska-Adamczyk M, Major P, Peôdziwiatr M. Bowel function after laparoscopic right hemicolectomy: a randomized controlled trial comparing intracorporeal anastomosis and extracorporeal anastomosis. *Surg Endosc.* 2022;36(7):4977–4982.

23. Espin E, Vallribera F, Kreisler E, Biondo S. Clinical impact of leakage in patients with handsewn vs stapled anastomosis after right hemicolectomy: a retrospective study. *Colorectal Dis.* 2020;22(10):1286–1292.

24. Golda T, Lazzara C, Zerpa C, et al. Risk factors for ileocolic anastomosis dehiscence; a cohort study. *Am J Surg.* 2020;220-(1):170–177.

25. Rahbari NN, Weitz J, Hohenberger W, et al. Definition and grading of anastomotic leakage following anterior resection of the rectum: a proposal by the International Study Group of Rectal Cancer. *Surgery.* 2010;147(3):339–351.

26. Gustafsson P, Jestin P, Gunnarsson U, Lindforss U. Higher frequency of anastomotic leakage with stapled compared to hand-sewn ileocolic anastomosis in a large population-based study. *World J Surg.* 2015;39(7):1834–1839.

27. Malerba V, Panaccio P, Grottola T, et al. Extracorporeal versus intracorporeal anastomosis after laparoscopic right hemicolectomy: cost-effectiveness analysis. *Ann Ital Chir*. 2020;91:49–54.

28. Ortenzi M, Balla A, Lezoche G, et al. Complications after bowel resection for inflammatory bowel disease associated cancer: a systematic literature review. *Minerva Surg*. 2022;77(3): 272–280.

29. Lee L, Abou-Khalil M, Liberman S, Boutros M, Fried GM, Feldman LS. Incidence of incisional hernia in the specimen extraction site for laparoscopic colorectal surgery: systematic review and meta-analysis. *Surg Endosc*. 2017;31(12):5083–5093.

30. van Oostendorp S, Elfrink A, Borstlap W, et al. Intracorporeal versus extracorporeal anastomosis in right hemicolectomy: a systematic review and meta-analysis. *Surg Endosc*. 2017; 31(1):64–77.

31. Hajibandeh S, Hajibandeh S, Mankotia R, Akingboye A, Peravali R. Meta-analysis of randomised controlled trials comparing intracorporeal versus extracorporeal anastomosis in laparoscopic right hemicolectomy: upgrading the level of evidence. *Updates Surg*. 2021;73(1):23–33.